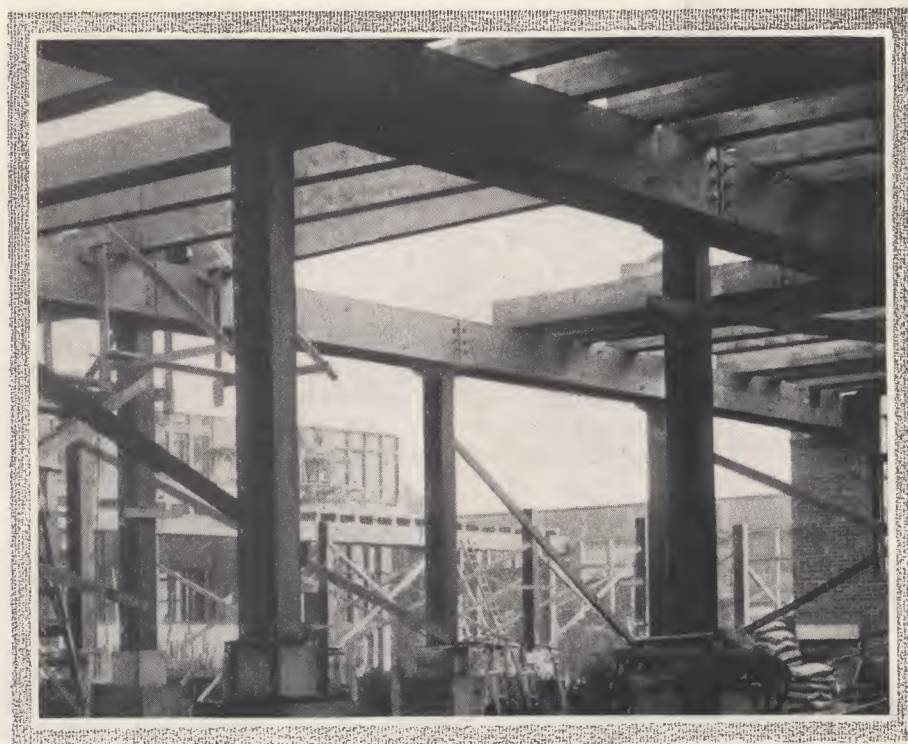
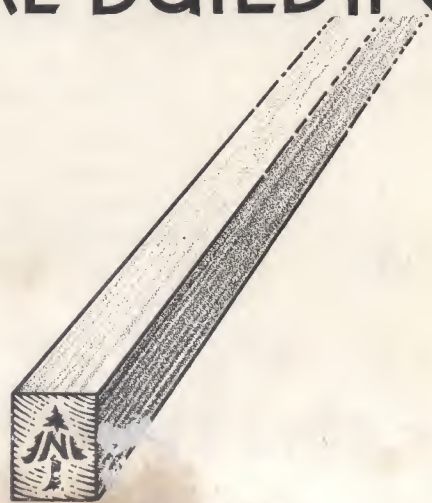


LUMBER
AND ITS
UTILIZATION



STANDARD INDUSTRIAL BUILDINGS



NATIONAL LUMBER
MANUFACTURERS
ASSOCIATION

VOL. IV · CH. 14



CONSTRUCTION INFORMATION SERIES



REPRINTED BY PERMISSION OF THE
NATIONAL FIRE PROTECTION ASSOCIATION

The following general specifications for Standard Industrial Buildings were drawn by a special committee of the National Fire Protection Association representing underwriters' interests, building consultants and building materials manufacturers. The primary purpose of the specifications is to develop types of buildings which will avoid serious loss of life or property in case of fire. They represent what is considered first class construction in this respect and buildings of timber, reinforced concrete or steel framed construction which fail in material respects to meet these specifications must be considered inferior as regards fire-resistive properties.

For the purposes of those considering use of heavy timber mill construction attention is called to Article 4 of General Requirements, which points out that within the height limits to which buildings are ordinarily built the same maximum floor areas are allowable for heavy timber construction as for other highly protected types.

Article 8 of General Requirements specifies allowable working stresses for lumber and timber conforming to the recommendations of the Department of Commerce Building Code Committee. Designers, however, are referred to the published working stresses for commercial grades of Southern yellow pine and Douglas fir (see publications Standard Specifications for Grades of Dense Southern Yellow Pine and Standard Grading and Dressing Rules for Douglas Fir listed on the inside back cover page of this text).

A list of publications of general interest to those designing buildings of heavy timber construction is given on the third cover page.

NATIONAL LUMBER MANUFACTURERS ASSOCIATION.

Cooperating Organizations:

British Columbia Loggers Association.
British Columbia Lumber & Shingle Manufacturers Association.
Maple Flooring Manufacturers Association.
National-American Wholesale Lumber Association.
National Association of Wooden Box Manufacturers.
Oak Flooring Manufacturers Association of the United States.
Service Bureau—American Wood Preservers Association.

Specifications* for STANDARD INDUSTRIAL BUILDINGS

FOREWORD

In developing specifications for building construction the policy of the Committee has been to produce a complete specification in each type of construction, so that the designer using the specification as a basis will have before him all of the important points which he should consider. Many of the construction details and recommendations are common to all three types. To print all of the details and recommendations in each specification would demand a large amount of space. With these two points in mind, the Committee has shown the important items as headings to articles in each type of construction. The details of items which are common to all three types have been collected in a section called General Requirements. When such a heading appears in any of the specifications, it is followed by a reference to the necessary article in General Requirements.

During the development of these specifications it became apparent that a specification would be very desirable for another type of industrial building in which might be incorporated various assemblies of construction not provided for in the specifications covering the Reinforced Concrete, Heavy Timber and Protected Steel Types. Such assemblies of construction concern themselves chiefly with the floor systems and subdivisions of areas in what might be termed a building of Composite Construction. The requirements for the walls and framing of such buildings, it was assumed, might be modifications of those already accepted as standard construction types. It appeared desirable to have specifications which would be helpful in improving the construction of certain industrial buildings otherwise erected without any consideration for their fire resistance, but of lessened protection from those types now offered as standard.

When the Committee attempted to draft specifications for Composite Buildings it was found that, due to the scarcity of available data on the performance of a number of the construction assemblies included therein (especially under the floor loads incident to industrial occupancy), the preparation of such specifications would best be deferred until further data are available.

CONTENTS

General Requirements

1. Classification.
2. Types of Construction.
3. Height.
4. Allowable Floor Area.
5. Definitions.

*The subject matter of these specifications is all new, not covered in previously adopted standards of the Association, with the exception of the section on Heavy Timber Construction, which supersedes the former Regulations governing Standard Mill (Slow Burning) Construction, Edition of 1918.

6. General Assumptions and Scope.
7. Egress Facilities.
8. Materials, Stresses and Workmanship.
9. Floor and Roof Openings.
10. Requirements for Shaft Enclosure.
11. Protection of Openings in Walls and Partitions.
12. Hall and Room Partitions.
13. Drainage.
14. Service and Miscellaneous Equipment.

Reinforced Concrete Construction

20. Definition.
21. General Assumptions and Scope.
22. Height.
23. Area.
24. Exits.
25. Quality of Materials and Stress Requirements.
26. Walls and Piers.
27. Wall Thicknesses.
28. Openings and Their Protection.
29. Columns.
30. Floor Construction.
31. Roof Construction.
32. Roof Structures and Coverings.

Heavy Timber Construction

40. Definition.
41. General Assumptions and Scope.
42. Framing Methods.
43. Height.
44. Area.
45. Exits.
46. Quality of Materials and Stress Requirements.
47. Walls and Piers.
48. Wall Thicknesses.
49. Openings and Their Protection.
50. Columns.
51. Column Connections.
52. Floor Construction.
53. Roof Construction.
54. Roof Structures and Coverings.

Steel Construction

60. Definition.
61. General Assumptions and Scope.
62. Skeleton Construction Defined.
63. Height.
64. Area.
65. Exits.
66. Quality of Materials and Stress Requirements.
67. Walls and Piers.
68. Wall Thicknesses.
69. Openings and Their Protection.
70. Fireproofing of Structural Members.
71. Fireproofing for Floor Construction.
72. Fireproofing for Roof Construction.
73. Roof Structures and Coverings.

Appendix

- I. Introduction.
- II. Types.
- III. Height.
- IV. Floor Areas.
- V. Dryness of Slabs and Concrete Floor Filling.
- VI. Water Damage.
- VII. Egress and Population.
- VIII. "Mill Construction."
- IX. Column Cap Protection.
- X. Roof Anchorage.
- XI. Lumber Standards.
- XII. References.

Specifications for STANDARD INDUSTRIAL BUILDINGS MORE THAN ONE STORY IN HEIGHT

GENERAL REQUIREMENTS

Article 1. Classification

Standard Industrial Buildings shall include all structures more than one story in height used for industrial purposes, such as factories, lofts and manufactories, mills, storage warehouses, workshops, etc. (See Appendix I.)

Article 2. Types of Construction

Buildings of this class, in which the fire hazard is recognized to be from moderate to high, shall conform to the minimum specification requirements for reinforced concrete, slow-burning heavy timber and protected steel construction. (See Appendix II.)

Article 3. Height

The Committee has reached no conclusions as to a maximum limit of height recommended for the skeleton-framed reinforced concrete or protected steel type of industrial building. For height limits of wall-bearing reinforced concrete, heavy timber and protected steel construction see Arts. 22, 43 and 63 respectively.

Appreciating the extreme irregularity of municipal zoning restrictions upon height, the Committee is nevertheless reluctant to specify an arbitrary limit which might be regarded as providing uniform safety to life and property in all cases or even under average conditions. In industrial buildings the size of undivided floor areas is so related to height of building that each might seem to be inversely proportional to the other. Discussion upon this point was solicited from the membership of the Association for the guidance or instruction of its Committee. No adverse criticism was recorded.

Attention is called to the fact that the limitations of floor area provided in Art. 4, General Requirements, are applicable only to such buildings as are less in height than three times the width of the abutting street. (See Appendix III.)

Article 4. Allowable Floor Areas

In standard industrial buildings conforming in all respects to these specifications, the maximum floor area in any story within exterior, party and fire walls shall not exceed the following:

4.1. Buildings not more than 6 stories or 75 feet in height:

4.11. Fronting on one street, 10,000 sq. ft. except that a deduction of 100 sq. ft. shall be made from this maximum for each 2 ft. of depth exceeding the frontage and that an addition of 100 sq. ft. may be made to this maximum for each 2½ ft. of frontage exceeding the depth.

4.12. Fronting on two streets, 12,000 sq. ft., except that an addition of 120 sq. ft. may be made to this maximum for each 3½ ft. of difference between the frontages on intersecting streets.

4.2. Buildings more than 6 stories or 75 feet in height:

4.21. Skeleton frame protected structures less in height than three times the width of abutting street (or average width of abutting streets), shall be restricted to an undivided floor area of 10,000 sq. ft. in any story within exterior, party and fire walls.

4.22. Such areas may be increased 50 per cent when further subdivided by fire division partitions into sections not exceeding 75 per cent of the area permitted by Art. 4.21.

4.3. When protected by approved automatic sprinklers any of the foregoing area limitations may be further in-

creased 100 per cent for buildings not more than, and 75 per cent for buildings exceeding, 6 stories or 75 feet in height.

NOTE. The foregoing limitations are based upon average conditions of use, occupancy and municipal fire department protection. However, because of the wide variations in these conditions, it is recommended that the fire hazard in each particular case be accurately analyzed and the degree of combustibility of contents and the method of storage of stock be surveyed, with their reflection upon the size of areas contemplated. Although the owner's desires are controlled by municipal or state requirements, the latter are likely to be less restrictive than the recommendations above. It is therefore recommended that the owner avail himself of the advice of underwriting authorities having jurisdiction in his territory. (See Appendix IV.)

Article 5. Definitions

For definitions of types covered by this Report, see Arts. 20, 40 and 60.

Other definitions and terms used in these specifications are indicated below.

AREA: The maximum area of any one story included within enclosing,—fire division or fire walls.

BEARING PARTITION: A partition which supports any load other than its own weight.

BEARING WALL: A wall which supports any load other than its own weight.

CEMENT: Wherever the word "cement" is used, it refers to Portland cement that will meet the requirements of the American Society for Testing Materials.

CEMENT-LIME MORTAR: A mortar composed of 1 part cement, 1 part hydrated lime, and not more than 6 parts of sand, proportioned by volume.

CEMENT MORTAR: A mortar made of cement and sand in the proportions of 1 part cement to not more than 3 parts sand by volume. Not more than 15 per cent of hydrated lime by volume may be added.

CONCRETE FILL: Fill for the top of floor or roof construction shall consist of concrete made of 1 part cement to 10 parts cinders, crushed brick, slag, tile or other suitable incombustible material, with sufficient fine aggregate as a binder to produce a homogeneous mixture.

FIRE DIVISION PARTITION: A wall or partition of fire-resistive materials subdividing an area in any story.

FIRE DIVISION WALL: A wall which subdivides a building to restrict the spread of fire in all stories from foundation to roof. In incombustible fire-resistive construction, it need not extend through the roof, nor necessarily be continuous in the same vertical plane through all stories. In combustible construction it shall extend through all floors and through the roof to form a parapet.

FIRE DOOR: (a) An automatic fire door is one which closes by means of a heat-actuated device. (b) A self-closing fire door is one kept normally closed by a mechanical device, and which closes automatically after being opened for use.

FIRE EXIT PARTITION: A sub-dividing partition built for the purpose of protecting life by providing an area of refuge.

FIREPROOFING: Such material and construction as shall meet the requirements of the fire test herein or hereafter specified.

FIRE-RESISTIVE: The term "fire-resistive" shall be applied to all material and construction which will comply with the fire tests specified under Fire-Resistive Classification following.

NOTE: The use of the term "Fireproof" is recommended discontinued. This general term has been erroneously applied to buildings and materials of a more or less fire-resistant or incombustible nature. Its indiscriminate use has produced much misunderstanding and has often engendered a feeling of security entirely unwarranted.

FIRE-RESISTIVE CLASSIFICATION: The classification or grading of materials or structures based upon fire resistance established by tests made or conducted in accordance with the American Standards Association "Specifications for Fire Tests of Building Construction and Materials."

FIRE TEST: Refers to the American Standard specified above.

FIRE WALL: A fire division wall which starts at the foundation and extends continuously through all stories to and above the roof to form a parapet.

HEIGHT: The vertical distance from the grade to the top of the highest point of the roof beams in the case of flat roofs, or to the average height of the gable in the case of roofs having a pitch of more than 20 degrees with the horizontal.

NOTE: When a building faces two or more streets having different grades, the measurement shall be taken at a facade on the street having the greatest grade. When the building does not adjoin the street, the measurement shall be taken from the average level of the ground adjoining.

INCOMBUSTIBLE: A term applicable to structures or materials which will not readily ignite and burn when subjected to fire.

LOT LINE WALL: A wall adjoining a lot line or property line.

PARAPET WALL: A wall which extends above the roof line and which bears no load, except as it may serve to support a tank.

PARTY WALL: A wall which is located above or upon a lot or property line, and is used jointly or adapted to such use.

STANDARD BUILDING: A building in which the lives of the occupants are properly safeguarded against fire and panic, so designed, assembled and equipped that damage resulting from exposure to fire from within or without shall be reduced to a minimum.

Article 6. General Assumptions and Scope

These specifications are based on the assumption that working stresses, floor loads, wind stresses, quality of materials and workmanship will conform to best engineering practice and that the structure will be designed and its construction supervised by a competent structural engineer, or architect.

Article 7. Egress Facilities

7.1. BASIS OF DETERMINATION: Egress facilities in industrial buildings shall be designed in accordance with the A. S. A. Standard Building Exits Code (Appendix VII), the means of egress and their relation to allowable calculation being determined by the type of construction, of occupancy hazard, protection of vertical openings, height in stories and use of horizontal exits and sprinkler protection.

7.2. MINIMUM REQUIREMENTS: Not less than two exits, remote from each other, shall be provided for every story, so located that no portion thereof shall be further from an exit in travel distance than 75 feet for high, 100 feet for moderate, and 125 feet for low hazard occupancies.

7.3. GRADE EXITS: At least one exit shall lead directly to grade at the first story from a smokeproof tower or enclosed stairway, and the distance between such grade exit doorways shall not exceed 150 feet. Revolving doors are prohibited.

7.4. DETAILED REQUIREMENTS: Smokeproof towers. Class A and B stairs, egress enclosures, ramps, horizontal exits, doors, corridors, elevators, slide escapes, and lighting

of exits, shall conform to the standard for same as applied to Factory Buildings in the recommendations of the Building Exits Code.

7.5. CALCULATION OF EXITS AND OCCUPANCY: The number of persons allowed in any story shall be determined by application of the principles outlined in Part B, General Requirements, of the Building Exits Code.

7.6. POSTING CAPACITIES: Each story and special section shall be posted with the allowable number of persons permitted therein and the industrial processes of the occupancy.

7.7. SHAFT ENCLOSURES: Requirements for shaft enclosures are minima and are intended for the preservation of life from fire. Where the specifications for shaft enclosure, found in the sections of this report, require construction superior to that recommended by the Building Exits Code (for egress purposes only), the detailed specifications of this report shall take precedence.

Article 8. Materials, Stresses and Workmanship. (See Appendix XII.)

8.1. Concrete and reinforced concrete shall conform in quality, design and inspection to the Report of the Joint Committee on Standard Specifications for Concrete and Reinforced Concrete.

8.2. The allowable working stresses for concrete and reinforced concrete shall conform to the report of the Building Code Committee of the U. S. Dept. of Commerce on "Requirements for Working Stresses in Building Materials."

8.3. Steel employed as reinforcement for reinforced concrete shall conform to the Standard Specifications of the American Society for Testing Materials (A 15-14) for "Billet Steel," (A 16-14) for "Rail-Steel" or (A 82-21 T) for "Cold-drawn Steel Wire."

8.4. Lumber and timbers used structurally in slow-burning heavy timber construction shall be of a commercial grade at least equivalent to the Basic Provisions for "Common" Structural Material prescribed in the American Lumber Standards. Minimum dimensions of lumber or timber, wherever specified in this report, refer to the standard trade (or nominal) sizes and not to the actual finished dimensions. (See Appendix XI.)

8.41. The allowable working stresses for lumber and timbers used for load bearing purposes shall conform to the Report of the Building Code Committee, U. S. Department of Commerce, "Requirements for Working Stresses in Building Materials."

8.5. Brick masonry shall conform to the U. S. Dept. of Commerce Report on "Recommended Minimum Requirements for Masonry Wall Construction," except that, in addition to the increased stress permitted therein for medium brick in structures designed in accordance with Art. 6, General Requirements, the maximum allowable stress per square inch for masonry of hard brick (A. S. T. M. Specification for Building Brick C 21-20) shall not exceed 260 lbs. when laid in cement-lime mortar, nor 340 lbs. in cement mortar.

8.6. Structural steel shall be inspected for conformity to the Standard Specifications of the American Society for Testing Materials (A 9-24) for "Structural Steel for Buildings." Allowable stresses, design, fabrication and erection of structural steel shall conform to the "Requirements for Working Stresses in Building Materials," reported by the Building Code Committee, U. S. Dept. of Commerce, and the "Standard Specification for Structural Steel for Buildings" of the American Institute of Steel Construction.

8.7. Reinforced gypsum fibre concrete shall contain not more than 15 per cent (by dry-mix weight) of wood chips, excelsior or fibre and shall develop, when dried to constant weight, in ultimate compressive strength of not less than 500 lbs. per square inch.

8.8. The U. S. Dept. of Commerce Report on Minimum Live Loads for Use in Design of Buildings shall govern the live loads, roof loads, movable partitions, live load reduc-

tions, wind pressures, posting and occupancy permits as employed in the design of industrial buildings.

8.9. Hollow building units and their construction shall conform to the U. S. Dept. of Commerce Report on "Recommended Minimum Requirements for Masonry Wall Construction." Hollow burned clay tile shall conform to the "Tentative Specifications and Tests for Hollow Burned Clay Fireproofing Partition and Furring Tile." (C 56-26 T) and "Tests for Hollow Burned Clay Load Bearing Wall Tile" (C 34-26), recommended by the American Society for Testing Materials.

Article 9. Floor and Roof Openings

9.1. Every series of floor openings providing communication between more than two stories for elevators, escalators, dumbwaiters, stairs, hoistways, chutes or for similar purposes shall be continuously enclosed in all stories by a shaft or shafts having fire-resistive walls as required by Art. 10, with all openings therein provided with approved fire doors, as required by Art. 11.24.

9.2. When an elevator, escalator, stairway, chute or similar communication connects two stories only, it shall be enclosed as required by Art. 9.1 in one story or the other.

9.3. Every opening for piping, power, conveyors or similar communications between stories shall be either properly fire-stopped or enclosed with approved incombustible protection.

9.4. Every shaft which pierces the roof shall terminate in a metal skylight glazed with thin glass, having an area not less than 75 per cent of the shaft cross section and protected above and below by heavy wire screens. In lieu of a skylight, the shaft may terminate in a penthouse or bulkhead above the main roof, provided the shaft walls least exposed have approved fire window frames and sash glazed with thin glass properly screened and having an aggregate area not less than 75 per cent of the shaft cross section.

9.5. Skylights over shafts shall be built up to a height not less than 3 feet above timber roofs, nor less than 16 inches above fire-resistive roofs.

Article 10. Requirements for Shaft Enclosure

10.1. The walls of shafts required by Art. 9 shall be constructed with adequate anchorage and bonding in conformity with the following requirements. For protection of openings in shaft walls, see Art. 11.24.

10.2. BEARING WALL SHAFTS: Every self-supporting shaft exceeding 9 square feet in cross section shall be constructed of the following:

10.21. Brick or plain concrete solid walls not less than 8 inches thick for the uppermost 30 feet, increasing 4 inches for each 30 feet or portion thereof below.

10.22. Reinforced stone concrete not less than 6 inches thick for the uppermost 30 feet, increasing 2 inches for each 30 feet or portion thereof below.

10.23. Hollow building tile of clay or concrete, hollow concrete blocks or hollow walls of brick, but not more than three stories or 40 feet in height, of which the top story wall shall be not less than 8 inches thick and 12 inches for the stories below.

10.24. Every self-supporting shaft used as bearing for floor members shall have walls of brick or plain concrete not less than 12 inches thick or of reinforced concrete not less than 8 inches thick.

10.3. NON-BEARING WALL SHAFTS: Every shaft carried on a structural frame and exceeding 9 square feet in cross section shall be constructed of the following:

10.31. Brick or plain concrete not less than 8 inches in solid thickness when supported at intervals not exceeding 30 feet.

10.32. Reinforced stone or cinder concrete not less than 5 inches thick when supported at intervals not exceeding 20 feet for stone and 15 feet for cinder concrete.

10.33. Hollow walls of brick or concrete block not less than 8 inches thick, hollow building tile or clay or concrete not less than 6 inches thick, hollow gypsum blocks not less than 5 inches thick, or other assembly of equivalent fire resistance not less than 5 inches thick when supported at intervals not exceeding 20 feet.

10.34. All non-bearing walls shall be securely anchored to the structural frame or tied to the fireproofing thereof without incorporation with the same.

10.35. All openings shall be framed in steel, with vertical members continuous and anchored to the floor and ceiling construction.

10.4. Every shaft, chute or similar enclosure not exceeding 9 square feet in area shall be continuous and constructed of brick, concrete, block, tile, gypsum, expanded metal or wire lath and Portland cement or gypsum plaster, or other assembly of equivalent fire resistance not less than 3 inches thick.

10.41. Every shaft serving more than 2 stories shall be enclosed top and bottom in construction equivalent to its walls, or in piercing the roof shall be capped or vented as required by Arts. 9.4 and 9.5.

10.5. Every shaft which continues into the top story shall be continuous through the roof and terminate in a skylight or in a bulkhead above. (See Art. 9.5.)

10.6. No shaft shall contain more than two elevators unless continuously sub-divided into sections of two elevators each by fire-resistive partitions not less than 2 inches thick.

10.7. Stairway and elevator shafts shall be separated in all stories by construction required for shaft walls.

Article 11. Protection of Openings in Walls and Partitions

NOTE. It is recommended that all wall openings above the first story less than 30 feet from exposing buildings, roofs or skylights, or on the building line of a street less than 30 feet wide, and all window openings in exterior and court walls more than 75 feet above grade, be protected by approved fire doors, fire windows, fire shutters or other approved exposure protection.

Attention is directed to the Report of the Committee on Protection of Openings in Walls and Partitions, N.F. P.A., for Suggested Practice for the Protection Against Fire Exposure of Openings in Fire-Resistive Walls, 1925.

11.1. EXTERIOR OPENINGS.

11.11. All exposing wall openings within 10 feet of doors, landings, platforms or stairs of smokeproof towers, stairways or other exit-ways shall be provided with approved self-closing fire doors or automatic fire windows or shutters.

11.12. Unless provided with approved fire doors, windows or shutters, all openings shall have solid wall separation between the bottom of lintels and sills of openings next above of not less than 3 feet, and shall have not less than 1 foot of spandrel between the lintel and ceiling.

11.13. All wall openings within 10 feet of intersecting party, fire or fire division partitions shall be protected by approved fire doors, windows or shutters.

11.14. Where fire shutters are employed, at least one row in every three vertical rows shall be readily opened from the outside and be so designated by distinguishing marking.

11.2. INTERIOR OPENINGS.

11.21. Openings in fire and party walls shall be limited to those absolutely essential to business needs.

Such openings shall be protected by approved fire wall (Class A) doors on each side of the wall.

11.22. Every opening in a fire division partition separating tenants, different occupancies, or sub-dividing fire areas shall be provided with an approved fire door.

11.23. Every opening in a fire or party wall or fire division partition serving as a required means of horizontal exit (see Art. 7) shall be provided with an approved fire door on each side of the wall: one a normally open automatic fire door, the other a self-closing swinging fire door.

11.24. Every opening to a shaft enclosure, whether for stairs, elevators, smokeproof tower or service shaft shall be provided with an approved shaft (Class B) fire door. All such doors, except manually operated elevator doors, shall be self-closing and be kept closed normally. Elevator shaft fire doors may be provided with not more than 72 sq. in. of wired glass, not more than 8 inches wide.

Article 12. Hall and Room Partitions

12.1. Hall and room partitions in fire-resistive structures shall be fire-resistive assemblies securely anchored or tied to all abutting construction.

12.11. Such partitions enclosing public corridors, subdividing sections (except fire division and fire exit partitions) shall be not less than 4 inches thick of solid concrete, solid or hollow brick, hollow building tile, concrete or gypsum block not less than 3 inches thick, reinforced concrete or solid partitions of Portland cement or gypsum plaster on expanded metal or wire lath not less than 3 inches thick, or other approved and equivalent fire-resistive assembly not less than 3 inches thick.

12.2. Hall and room partitions in heavy timber construction may be the same as required by Art. 12 when supported by foundations or fire-resistive construction, or the following:

12.21. Such partitions enclosing public corridors, subdividing sections (except fire division and fire exit partitions) in buildings more than 3 stories high, shall be not less than 3 inches thick of solid or hollow brick, hollow building tile of clay, concrete or gypsum, not less than 2 inches thick for solid partitions of Portland cement or gypsum plaster on expanded metal or wire lath, or other approved and equivalent fire-resistive assembly not less than 2 inches thick.

12.3. Other partitions in sprinklered heavy timber construction, or when unsprinklered and not more than 3 stories in height, may be solid, of two-inch dressed and splined plank or two thicknesses of one-inch matched board with broken joints.

12.4. No hollow stud partitions, unless entirely filled with incombustible, porous fire stopping, shall be employed in heavy timber construction.

Article 13. Drainage. (See Appendix VI.)

Merchandise, stock and stored materials shall be protected from excessive water damage from any cause by means of interior floor drains, outlets and sumps, or scuppers. Such floor drains or outlets shall discharge into interior drainage lines, or into stair or other protected shaft enclosures, or through exterior walls by means of approved scuppers; such discharge to be provided in all stories in which water may be impounded.

The aggregate intake capacity, or cross-sectional area of outlets on any one floor shall be sufficient to promptly carry off not less than 75 per cent of the estimated water discharged in such story. Adequate provision shall be

made for discharge at the lowest levels of all shafts and sumps to which water may flow.

NOTE: Reference is made to waterproofing of floors, Appendix VI.

Article 14. Service and Miscellaneous Equipment

14.1. The room or rooms in which boilers and all power and operating machinery are located shall be separated from other portions of the building by a 12-inch brick or 8-inch reinforced concrete wall, having an automatic fire door at each opening, and such rooms shall not have direct communication with the floor above. The floor over such rooms shall be of fire-resistive construction.

14.2. A standpipe shall be installed at each stair enclosure. The installation of standpipe and hose shall conform to the regulations for the Installation of Standpipe and Hose Systems, as recommended by the National Fire Protection Association.

14.3. Where any portion of the building on the grade floor, or any floor below grade is used for the storage or exhibition for sale of merchandise, an approved automatic sprinkler equipment shall be provided in such portion.

14.4. All electrical equipment shall be installed and maintained in accordance with the requirements of the National Electrical Code.

14.5. All heating, ventilating and other service equipment shall be separated from other portions of the building by fire division partitions, and all openings in same shall be provided with approved fire doors.

14.6. Where the heating is by blower or indirect systems, the ducts shall be equipped throughout with properly located valves. Any material of a flammable nature shall be protected from the flame or heat of the gas lighting, heating or ventilating apparatus by metal and asbestos or other fire-resistive, non-conducting material. Where gas is supplied, approved outside cut-off devices shall be provided. No swinging gas fixtures shall be used.

14.7. All ordinary chimneys and flues serving low pressure heating devices and forming a part of the building shall conform to the "Standard Ordinance for Chimney Construction" recommended by the National Board of Fire Underwriters. Larger flues and chimneys for high pressure work shall conform to best engineering practice.

14.8. All hazardous processes, installations and operations peculiar to manufacturing and industrial operations shall conform to their respective regulations of the National Board of Fire Underwriters, as recommended by the National Fire Protection Association.

14.9. Automatic sprinklers, fire alarm first-aid appliances and similar fire protection devices shall be installed, equipped and maintained in accordance with the regulations of the National Board of Fire Underwriters for such equipment, as recommended by the National Fire Protection Association.

MINIMUM REQUIREMENTS FOR REINFORCED CONCRETE CONSTRUCTION

Article 20. Definition

Buildings of reinforced concrete construction are those in which all columns, girders, beams, floor and roof slabs are of reinforced concrete and in which all walls of buildings more than 5 stories above grade are supported by a reinforced concrete skeleton frame.

Article 21. General Assumptions and Scope

See General Requirements, Art. 6.

Article 22. Height

Wall bearing reinforced concrete structures shall not exceed 5 stories or 60 feet in height. For reinforced con-

crete skeleton construction, see General Requirements, Art. 3. (See also Appendix III.)

Article 23. Area

See General Requirements, Art. 4, also Appendix IV.

Article 24. Exits

Means of egress shall be provided, constructed and maintained in accordance with General Requirements, Art. 7. (See also Appendix VII.)

Article 25. Quality of Materials, and Stress Requirements

All materials, methods and working stresses shall conform to the provisions of General Requirements, Art. 8.

Article 26. Walls and Piers

26.1. FOOTINGS: Buried footings are not considered to come within the province of this specification.

26.2. PIERS: Piers shall be built solid of plain or reinforced concrete or of solid masonry in accordance with best engineering practice. (See General Requirements, Art. 8.)

26.3. FOUNDATIONS: Foundation walls shall be built solid of plain or reinforced concrete or of solid masonry laid in cement mortar.

26.4. FIRE, PARTY AND LOT LINE WALLS: Fire, party and lot line walls shall be built solid of plain or reinforced concrete or of solid brick masonry laid in cement-lime or cement mortar.

26.5. EXTERIOR WALLS: Exterior, enclosure and panel walls shall be built of stone, solid or hollow brick masonry, hollow building tile of medium or hard grade or of approved concrete block all laid in cement-lime or cement mortar, or of plain or reinforced concrete, or a combination of these materials, or may be built of or faced with other equivalent and suitable materials qualifying under strength, fire and water tests prescribed by the building official having jurisdiction.

26.6. FIRE DIVISION PARTITIONS: Fire division partitions shall be anchored or tied to all abutting structural members and shall extend to the underside of the floor or roof construction above. All such divisions shall be constructed of the materials prescribed for exterior walls, or gypsum block may be used.

Article 27. Wall Thicknesses

27.1. FOUNDATIONS: Foundation walls shall have a thickness suitable for the loads and thrusts to be sustained.

27.2. FIRE, PARTY AND LOT LINE WALLS: Fire, party and lot line walls shall be not less than 8 inches thick if of reinforced concrete, nor less than 12 inches thick of any other material.

27.3. EXTERIOR WALLS: Bearing walls shall be not less in thickness than as required by Art. 47 for similar walls in heavy timber construction. (See also General Requirements, Art. 8.5.) Enclosure or panel walls shall be not less than 8 inches thick when built of brick, hollow building tile, approved concrete block or plain concrete, nor less than 6 inches thick of reinforced concrete, or of comparable thickness if of other equivalent and suitable material.

27.4. FIRE DIVISION PARTITIONS: Fire division partitions shall be not less than 4 inches thick of reinforced concrete, 5 inches thick of cored or solid gypsum block, nor less than 6 inches thick of other materials permitted by Art. 26.5.

Article 28. Openings and Their Protection

All openings in floors, shafts, walls, partitions and roofs and their protection shall conform to the provisions of General Requirements, Arts. 9, 10, 11 and 12.

Article 29. Columns

29.1. Reinforced concrete columns shall have a pro-

tection of concrete not less than 2 inches thick outside of the steel reinforcing. Such protection shall be placed monolithically with the concrete of the column. For concrete of which the coarse aggregate contains 50 per cent or more of quartz, chert, or similar minerals, the protective covering shall be not less than 2½ inches thick outside of the steel reinforcing, and shall be reinforced by steel mesh (openings not exceeding 3 inches) embedded not less than 1 inch from the outside finished surface. (See Note, Art. 70.)

29.2. The effective area of reinforced concrete columns shall include only the area within the protective covering. The corners of rectangular columns shall be bevelled at least 1½ in. or be rounded to a radius of 1½ in. or more, except where protected by angles or other metal guards. No pipes, ducts or wires shall be placed within the area required for fireproofing. This provision is not to preclude the use of inserts or conduit outlet boxes in the area outside of the column core.

29.3. For additional column protection, see Art. 70.45.

Article 30. Floor Construction. (See Note, Art. 70.)

30.1. Floor and roof construction shall be any of the recognized types of reinforced concrete construction, including combinations of clay or concrete tile or gypsum block and reinforced concrete, designed according to best engineering practice. All reinforcement in slabs shall have a protection on the underside of not less than 1 inch of concrete cast monolithically with the concrete of the slab. Joists in tile and joist floors shall be considered as solid slabs with respect to this provision; in open joist construction, the minimum protection in the joists shall be 1½ inches.

30.2. For girders, the protective covering shall be at least 2 inches, and for beams, 1½ inches, and shall be cast monolithically with the concrete of the girder or beam.

30.3. A minimum solid thickness of 4 inches shall be required for all reinforced concrete floors; when of ribbed tile and joist construction the total thickness shall be not less than 6 inches. (See General Requirements, Art. 13, also Appendix VI.) When a granolithic finish or topping is placed so as to be integral with the body of the slab, its thickness may be considered as part of the required minimum slab thickness.

30.4. Where surface wooden flooring is secured to sleepers, the spaces between shall be completely filled with incombustible material up to the underside of the flooring, or to the underside of sub-flooring, where employed. (See Appendix V.)

Article 31. Roof Construction

31.1. FLAT ROOFS: Flat roofs shall be considered as those having a slope of less than 15 degrees above the horizontal.

31.11. All flat roofs and requirements as to fireproofing thereof shall conform to the requirements of Art. 30 for Floor Construction.

31.2. SLOPING ROOFS: Sloping roofs shall be considered as those having a slope of 15 or more degrees above the horizontal.

31.21. All sloping roof construction and requirements as to fireproofing thereof shall conform to the requirements of Article 30 for Floor Construction, except that such roof slabs may have a minimum thickness of 3 inches.

31.3. For anchorage of roof members, see Appendix X.

Article 32. Roof Structures and Coverings

All structures on or above the roof shall be of incombustible fire-resistive construction.

Roof coverings shall be not less than equal to Class "B" as classified by the Underwriters' Laboratories.

For anchorage of roof coverings, see Appendix X.

MINIMUM REQUIREMENTS FOR SLOW-BURNING HEAVY TIMBER CONSTRUCTION

Article 40. Definition

Buildings of slow-burning, heavy timber construction are those in which all walls are of masonry and in which the interior framing is of large timbers, or in part of protected steel or reinforced concrete, and the plank floors and roof are arranged in heavy solid masses and smooth flat surfaces, avoiding thin or sharp projections and concealed or inaccessible spaces. (See Appendix VIII.)

Article 41. General Assumptions and Scope

These specifications, based on the practice developed in different sections of the country, embrace the three general methods of heavy timber assembly for substantial commercial structures. Though common in basic characteristics as defined, they are differentiated by their respective framing methods. (See General Requirements, Art. 6.)

Article 42. Framing Methods

42.1. SLOW-BURNING, HEAVY TIMBER CONSTRUCTION, GIRDER TYPE: To include buildings with floors of heavy plank laid flat upon large timber girders which are spaced not less than 8 feet on centers and supported by wood posts or columns at intervals of not less than 12 feet.

42.2. SLOW-BURNING, HEAVY TIMBER CONSTRUCTION, BEAM AND GIRDER TYPE: To include buildings with floors of heavy plank laid flat upon large timber beams spaced not less than 4 feet on centers and supported by large timber girders and wood posts or columns spaced according to sound engineering practice.

42.3. SLOW-BURNING, HEAVY TIMBER CONSTRUCTION, LAMINATED TYPE: To include buildings with floors of heavy plank laid on edge upon large girders spaced not less than 12 feet on centers and supported by wood posts or columns at intervals preferably not less than 16 feet.

GENERAL: The substitution of protected steel or reinforced concrete framing for portions of the structure shall not be considered to alter the type. (See Arts. 50.2 and 52.5.)

Floors of all the above framing methods shall be provided with a top floor to take the wear and give a finished surface. (See Art. 52.3.)

Article 43. Height

Buildings of slow-burning, heavy timber construction when equipped with approved automatic sprinklers shall not exceed 75 feet nor 6 stories in height. When not equipped with sprinklers they shall not exceed 52 feet nor 4 stories in height.

Article 44. Floor Area

(See General Requirements, Art. 4, also Appendix IV.)

Article 45. Exits

Means of egress shall be provided, constructed and maintained in accordance with General Requirements, Art. 7. (See also Appendix VII.)

Article 46. Quality of Materials and Stress Requirements

All materials, methods and working stresses shall conform to the provisions of General Requirements, Art. 8.

Article 47. Walls and Piers

47.1. FOOTINGS: Buried footings are not considered to come within the province of this specification.

47.2. PIERS: Piers shall be built solid of plain or reinforced concrete, or of solid masonry in accordance with best engineering practice. (See General Requirements, Art. 8.)

47.3. FOUNDATIONS: Foundation walls shall be built solid of plain or reinforced concrete or of solid masonry laid in cement mortar.

47.4. Fire, party and lot line walls shall be built solid of plain or reinforced concrete, or of solid brick masonry laid in cement-lime or cement mortar.

47.5. EXTERIOR WALLS: Exterior, enclosure and panel walls shall be built of stone, solid or hollow brick masonry, hollow building tile of medium or hard grade, or of approved concrete block, all laid in cement-lime or cement mortar; or of plain or reinforced concrete, or a combination of these materials; or may be built of or faced with other equivalent and suitable materials qualifying under strength, fire, and water tests, prescribed by the building official having jurisdiction.

47.6. FIRE DIVISION PARTITIONS: Fire division partitions shall be constructed of the materials prescribed for exterior walls or of gypsum block. Such partitions shall be supported at each story by protected steel or by reinforced concrete girders or slabs and shall be vertically continuous in all stories. They shall be anchored or tied to all abutting structural members other than wood posts or columns.

47.7. PARAPETS: All exterior, party and fire walls shall have parapets not less than 3 feet in height above the roof. Such parapets shall be of reinforced concrete not less than 8 inches in thickness, or of masonry not less than 12 inches thick laid in cement mortar. Copings shall be securely attached to the top of parapets.

Article 48. Wall Thicknesses

48.1. FOUNDATIONS: Foundation walls shall have a thickness suitable for the loads and thrusts to be sustained, but not less than 16 inches thick, except in the case of unexcavated basements where the foundation may be of the same thicknesses as first story walls.

48.2. EXTERIOR, LOT LINE AND FIRE WALLS: Bearing walls shall be not less than 12 inches thick for the uppermost two stories of their height, nor less than 16 inches for the next three stories below, and not less than 20 inches for the first story and/or unexcavated basement of a 6-story building. Story height shall not exceed 15 times the wall thickness. For non-bearing walls in heavy-timber construction, see Articles 27.3 and 68.3.

48.3. PARTY WALLS: Party walls serving as bearing for joint use may be required 4 inches thicker than the corresponding thicknesses for exterior, lot line and fire walls.

48.4. GENERAL: All walls shall be securely anchored and bonded at points of intersection and shall be anchored or tied to all girders and beams at their bearings. (See Appendix X.)

48.5. FIRE DIVISION PARTITIONS: Fire division partitions shall be not less than 4 inches thick of reinforced concrete, 5 inches thick of cored or solid gypsum block, nor less than 6 inches thick of other materials permitted by Article 26.5.

Article 49. Openings and Their Protection

All openings in floors, shafts, walls, partitions and roofs and their protection shall conform to the provisions of General Requirements, Arts. 9, 10, 11 and 12.

Article 50. Columns

50.1. Timber columns shall be of sufficient size to support their loads without exceeding allowable unit stresses, but shall be in no case less than 8 inches in least dimension. All corners shall be rounded or chamfered.

50.2. Columns of other materials may be substituted for timber columns when designed in accordance with best

engineering practice and protected to meet the requirements of Articles 29 and 70.

Article 51. Column Connections

51.1. Timber columns shall be superimposed throughout all stories on reinforced concrete or metal caps with brackets or shall have ends connected by properly designed steel or iron cap, pintle and base-plate. (See Appendix IX. Wood bolsters may be used to support roof girders only.)

51.2. Column and girder connections shall be of fire-resistive construction, or be protected by fire-resistive materials affording not less than a 1-hour fire rating.

51.3. Posts shall in no case rest directly on floor timbers nor on masonry foundations.

51.4. Timber floor beams or girders, abutting at columns, shall be fastened together with heavy iron dogs or with substantial metal straps or plates firmly attached to the beams. The ends of such beams or girders, where supported by masonry, shall rest in metal wall boxes or in niches of sufficient size to permit free ventilation about the wood. Provision shall be made for free release of such beam ends in case of failure at the centers of spans. Beams and girders of other materials shall also be securely anchored to the walls and columns. (See Appendix X.)

Article 52. Floor Construction

52.1. Girders, beams and floors shall be of a size or thickness sufficient to support their live and dead loads without exceeding the unit stresses herein specified, but in the case of timber girders and beams shall be not less than 6 inches in thickness, nor less than 10 inches in depth. Girders or beams of other materials shall be protected to meet the requirements for a one-hour rating by the Standard Specifications for Fire Tests.

52.2. Floor planking shall be not less than 3 inches (nominal) thick and preferably of splined lumber. Tongued and grooved planking may be used. Floor planking 4 inches or more in thickness shall be grooved for splines. The groove shall be 13/16 inch thick and 7/16 inch wide, admitting splines 3/4 inch x 3/4 inch in size (actual). (See General Requirements, Art. 13, also Appendix VI.)

52.3. All floors shall be covered with a top or wearing floor of not less than 1 inch matched boards, wood blocks or other equivalent wearing surfaces. Top flooring shall not extend closer than 1/2 inch to walls to allow for swelling in case the floor becomes wet. This space shall be covered by a moulding so arranged that it will not obstruct movements of the flooring. The joint between floor planking and the wall shall be closed from below by solid corbelled masonry beneath the plank.

52.4. Laminated floors shall not be attached to floor beams or girders, and adequate provision shall be made around columns and at walls for their expansion and contraction.

52.5. Floors, or portions thereof, of other materials may be substituted for plank and girder floors when designed in accordance with best engineering practice and protected to meet the requirements of Articles 30 and 71.

Article 53. Roof Construction. (See Appendix X.)

53.1. Roof construction shall comply in all respects with the requirements for floor construction, except that planking may be not less than 2 1/2 inches thick, and without top flooring. Roof planking shall not extend over fire or party walls.

53.2. Cornices and facias shall be wholly of incombustible materials.

Article 54. Roof Structures and Coverings

54.1. All structures on or above the roof shall be of construction equivalent to respective requirements within

the building as to structural integrity and slow-burning qualities.

54.2. Roof coverings shall be not less than equal to Class "B" as classified by the Underwriters' Laboratories.

MINIMUM REQUIREMENTS FOR PROTECTED STEEL CONSTRUCTION

Article 60. Definition

Buildings of steel construction are those in which all columns, girders, beams, trusses and purlins are of protected structural steel, and in which all walls of buildings more than 5 stories above grade are supported by a steel skeleton frame.

Article 61. General Assumptions and Scope

See General Requirements, Art. 6.

Article 62. Skeleton Construction Defined

62.1. The skeleton frame of such structures shall be considered as the columns and girders, beams, trusses or spandrels having rigid connections to the columns. The members of floor or roof panels having no connection to the columns shall be considered secondary members.

62.2. The skeleton frame shall provide all the necessary rigidity for the structure, and the secondary members need not be considered as affecting the vertical rigidity unless designed to carry horizontal forces to the skeleton frame and into the foundations.

Article 63. Height

Wall bearing protected steel structures shall not exceed 5 stories or 60 feet in height. For steel skeleton construction, see General Requirements, Art. 3. (See also Appendix III.)

Article 64. Area

See General Requirements, Art. 4, also Appendix IV.

Article 65. Exits

Means of egress shall be provided, constructed and maintained in accordance with General Requirements, Art. 7. (See also Appendix VII.)

Article 66. Quality of Materials and Stress Requirements

All materials, methods and working stresses shall conform to the provisions of Art. 8, General Requirements.

Article 67. Walls and Piers

67.1. FOOTINGS: Buried footings are not considered to come within the province of this specification.

67.2. PIERS: Piers shall be built solid of plain or reinforced concrete or of solid masonry in accordance with best engineering practice. (See General Requirements, Art. 8.)

67.3. FOUNDATIONS: Foundation walls shall be built solid of plain or reinforced concrete or of solid masonry laid in cement mortar.

67.4. FIRE, PARTY AND LOT LINE WALLS: Fire, party and lot line walls shall be built solid of plain or reinforced concrete or of solid brick masonry laid in cement-lime or cement mortar.

67.5. EXTERIOR WALLS: Exterior enclosure, and panel walls shall be built of stone, solid or hollow brick masonry, hollow building tile of medium or hard grade, or of approved concrete block, all laid in cement-lime or cement mortar, or of plain or reinforced concrete, or a combination of these materials, or may be built of or faced with other equivalent and suitable materials qualifying under

strength, fire and water tests prescribed by the building official having jurisdiction.

67.6. FIRE DIVISION PARTITIONS: Fire division partitions shall be anchored or tied to all abutting structural members and shall extend to the underside of the floor or roof construction above. All such divisions shall be constructed of the materials required for exterior walls or gypsum block may be used.

Article 68. Wall Thicknesses

68.1. FOUNDATIONS: Foundation walls shall have a thickness suitable for the loads and thrusts to be sustained.

68.2. FIRE, PARTY AND LOT LINE WALLS: Fire, party and lot line walls shall be not less than 8 inches thick if of reinforced concrete nor less than 12 inches thick for any other material.

68.3. EXTERIOR WALLS: Bearing walls shall be not less in thickness than as required by Art. 47 for similar walls in heavy timber construction. (See also General Requirements, Art. 8.5.) Enclosure or panel walls shall be not less than 8 inches thick when built of brick, hollow building tile, approved concrete block or plain concrete, nor less than 6 inches thick of reinforced concrete, or of comparable thickness if of other equivalent and suitable material.

68.4. FIRE DIVISION PARTITIONS: Fire division partitions shall be not less than 4 inches thick of reinforced concrete, 5 inches thick of cored or solid gypsum block, nor less than 6 inches thick of other approved materials permitted by Art. 67.5.

Article 69. Openings and Their Protection

All openings in floors, shafts, walls, partitions and roofs, and their protection shall conform to the provisions of General Requirements, Arts. 9, 10, 11 and 12.

Article 70. Fireproofing of Structural Members

NOTE. The purpose of fireproofing is to insulate metal members against a rise of temperature that would seriously impair their strength and usefulness. The ideal method of stipulating requisite protection of steel against the effects of fire would be to express in terms of time, the insulation which should be afforded. Since, in the present state of the art, sufficient information is not available as to the insulating value of various building materials, the following provisions are expressed in terms of thickness based upon the best current knowledge of performance of the stated materials.

70.1. GENERAL PROVISIONS.

70.11. All metal structural members which support loads or resist stresses shall have a protection of fireproofing as herein specified. The protection material shall be brick, concrete, hollow building tile or gypsum, conforming to the provisions of General Requirements, Art. 8.

70.12. Plaster shall not be considered a part of any required fireproofing for metal structural members in standard fire-resistive industrial buildings except as provided in Arts. 70.42, 70.43, 70.53 and 72.1.

70.13. The extreme outer edges of lugs, brackets, and similar supporting metal may project to within 1 inch of the outer surface of the protection hereinafter specified.

70.14. Poured-in-place concrete or gypsum protection for all structural members shall be reinforced by suitably spaced and designed steel anchors not less than $\frac{1}{8}$ inch in thickness if flat or No. 12 gauge if of wire.

70.15. Brick or blocks used for fireproofing shall be accurately fitted and bonded and have all spaces between the fireproofing casing and the metal solidly back-filled (without voids) with mortar, with masonry laid in mortar, or with concrete.

70.16. Fireproofing of metal structural members shall not be integral with abutting non-bearing walls but may lend lateral support by being tied or anchored thereto without incorporation with the same.

70.17. All brick or blocks used for fireproofing shall be set in Portland cement mortar, except that gypsum blocks shall be set in gypsum mortar.

70.18. No pipes, ducts or wires shall be placed within the area required for fireproofing. This provision is not to preclude the use of small inserts or small conduit outlet boxes, provided the anchors for inserts and the pipes and conduits which supply such boxes are not located in the fireproofing.

70.2. PROTECTION OF WALL COLUMNS: All columns which support steel girders carrying exterior walls, and all columns which are built into walls and support floors only, shall have the protection against corrosion required by Article 8.6, and be enclosed in a casing of brick masonry not less than $3\frac{1}{4}$ inches thick or not less than 3 inches of concrete; all to be well bonded or anchored into the masonry of the enclosing walls.

70.3. PROTECTION OF WALL GIRDERS: Wall girders shall have the same protection as required for wall columns except that the extreme outer edge of the flanges of beams, or plates or angles connected to the beams, may project within 2 inches of the outside surface of such casing. The inside surfaces of the girders shall be similarly protected by masonry, or if projecting inside the walls, they shall be protected by concrete, hollow building tile, gypsum, or other approved fireproofing material not less than 2 inches thick.

70.4. INTERIOR COLUMNS.

70.41. Interior columns shall be enclosed in a continuous casing of fireproofing, which shall cover the columns at all points to a thickness of not less than 3 inches, except that non-siliceous poured concrete or cast-in-place gypsum may be not less than 2 inches thick.

70.42. For concrete of which the coarse aggregate contains 50 per cent or more of quartz, chert, or similar minerals, the fireproofing shall be 1 inch thicker and shall be reinforced with metal mesh as required by Art. 29.1 or in lieu of additional thickness may be covered with expanded metal or wire lath and cement or gypsum plaster 1 inch thick.

70.43. Block column covering shall be securely anchored to steel with approved anchors or ties, or additional bond shall be provided for stability by the use of metal fabric reinforcement in horizontal joints. Galvanized tie wire, not less than No. 12 gauge, may be tightly bound around each course of blocks when column casing is plastered or in sprinklered buildings, unplastered.

70.44. Columns subject to moisture and corrosion shall be adequately protected before application of fireproofing.

70.45. Where subject to mechanical injury from trucking or handling of merchandise fireproofing shall be protected by suitable jacketting.

70.5. PROTECTION OF STEEL GIRDERS, BEAMS AND TRUSSES.

70.51. The webs and bottom flanges of interior girders and trusses shall be protected with fireproofing (as specified in Art. 70.11) not less than 2 inches thick at all points. Beams, lintels, and all other structural members, except roof trusses and roof purlins (see Art. 72.1) shall be similarly protected with fireproofing not less than $1\frac{1}{2}$ inches thick.

70.52. If hollow building tile or gypsum block be used for protection, the lower flanges of beams and similar members shall be encased with self-anchoring and well bonded solidly mortared skewbacks or soffit fillers.

70.53. Steel angle or channel struts or other minor structural framing not elsewhere provided for, which are used for support in any wall, partition, or other

construction, shall be protected by not less than 1 inch of expanded metal or wire lath and cement or gypsum plaster.

Article 71. Fireproofing for Floor Construction

71.1. Fire-resistive construction between steel floor beams shall consist of reinforced concrete slabs, arches and combinations as specified in Art. 30, segmental arches of brick, segmental or flat arches of hollow building tile, poured-in-place and pre-cast reinforced gypsum or other equivalent and suitable materials qualifying under strength, fire and water tests prescribed by the building official having jurisdiction.

71.2. All segmental arches shall have a rise of 1 inch to the foot of span. All tie-rods shall be completely encased to a depth of at least 2 inches in fireproofing material which shall extend into and be anchored to the arch.

71.3. The spacing of floor beams in fire-resistive construction shall not exceed 8 feet on centers except when the slabs between them are composed of reinforced stone or gravel concrete, in which case they shall be limited by the design as prescribed under General Requirements, Art. 8.

71.4. BRICK ARCHES: Segmental arches of brick shall have a thickness of not less than $3\frac{1}{4}$ inches for spans of 5 feet or less, and 8 inches for spans exceeding 5 feet and not exceeding 8 feet.

71.5. HOLLOW TILE ARCHES: Hollow tile used for floor arches shall be of uniform density and hardness and be properly keyed within the middle third of the span. All such tile shall have not less than two cellular spaces in the depth.

71.51. Segmental arches shall be not less than 6 inches in depth.

71.52. Flat arches shall be not less than 8 inches in depth, nor less than $1\frac{1}{2}$ inches for each foot of span between the beams, exclusive of any depth of tile projecting below the beams.

71.53. The shells of arch tile shall be not less than $\frac{3}{4}$ inch in thickness, and the webs shall be not less than $\frac{1}{2}$ inch in thickness. The skewbacks of all hollow tile arches shall have shells and webs not less than $\frac{3}{4}$ inch thick. The allowable extreme fibre stress in compression in such floor tile shall be taken as 500 pounds per square inch on net section.

71.6. CONCRETE ARCHES AND SLABS: All reinforced concrete arches, slabs and combinations shall be constructed in accordance with General Requirements, Art. 8. Solid reinforced concrete and gypsum slabs shall have a minimum thickness of 4 inches. For composite slabs, see Art. 30.

71.7. POURED-IN-PLACE REINFORCED GYPSUM SLABS: All such systems shall conform to the provisions of General Requirements, Art. 8.7, and shall be not less than 4 inches thick. They shall be designed with a safety factor of not less than four times the total dead and live loads. The stress in the suspension wires or cables shall be determined by the following formula:

$$T = \frac{WL}{8d} \sqrt{L^2 + 16d^2}$$

T = Maximum tension in wires or cables in lbs. per foot width of slab.

W = Load in lbs. per sq. foot.

L = Clear span between supports in feet.

d = Deflection or "Dip" of wires or cables in feet at center of span

The wires or cables shall be of cold drawn steel in which the allowable working stress shall not exceed 20,000 pounds per square inch.

71.8. Where surface wooden flooring is secured to sleepers, the spaces between shall be completely filled with incombustible materials up to the underside of the flooring, or to the underside of sub-flooring, where employed. (See Appendix V.)

Article 72. Fireproofing for Roof Construction

72.1. Unless protected as for girders (see Art. 70.51), roof trusses shall be boxed in with metal fabric (not less than No. 12 wire) having large mesh and wholly encased in expanded metal or wire mesh and cement or gypsum plaster not less than 1 inch in thickness, furred off from the bottom chord 1 inch.

72.2. FLAT ROOFS: Flat roofs shall be considered as those having a slope of less than 15 degrees above the horizontal.

72.21. All girders, beams and other structural supports for flat roofs (except as permitted by Art. 72.1) shall be protected as required by Arts. 70.5 and 71.

72.3. SLOPING ROOFS: Sloping roofs shall be considered as those having a slope of 15 or more degrees above the horizontal.

72.31. All girders, beams and other structural supports for sloping roofs (except as permitted by Art. 72.1) shall be protected as required by Arts. 70.5 and 71.

72.32. Concrete or gypsum slab construction for sloping roofs shall have a minimum thickness of 3 inches.

72.33. Concrete, gypsum or burned clay roof tile, properly reinforced and having a minimum thickness of three inches, may be used over protected steel supporting members spaced not to exceed 8 feet.

72.4. For anchorage of roof members see Appendix X.

Article 73. Roof Structures and Coverings

73.1. All structures on or above the roof shall be of incombustible fire-resistive construction.

73.2. Roof coverings shall be not less than equal to Class B as classified by the Underwriters' Laboratories. For anchorage of roof coverings see Appendix X.

APPENDIX

Informative data and explanatory matter which do not specifically constitute requirements but may be necessary to clarify the provisions of the report, to indicate reasons for deviation from previously accepted standard or to give references, are treated in the following sections.

I. These specifications are not intended to apply as minimum requirements for 1-story buildings. Reinforced concrete and protected steel structures include: (1) Wall-bearing structures more than 1 story but not more than 5 stories or 60 feet in height; (2) multi-story skeleton framed structures.

II. Types

Combination of heavy timber construction with reinforced concrete and protected steel types shall conform to the detailed requirements for those portions employed respectively. The Committee has considered the study of combinations and deviations from the "Standard" types outlined in Art. 2, General Requirements. Due to an expressed demand for specifications for Industrial Buildings of the three types, reinforced concrete, timber and steel, recommendations for other assemblies and for 1-story structures have been deferred until after completion of these Standards.

III. Height

Since the 1926 Progress Report, the Committee has continued to study the question of height limitation for all three types of standard industrial buildings. The previously suggested limit of 150 feet or 12 stories for reinforced concrete construction has been retracted. It is assumed that whatever limit of height is decided upon for industrial buildings of reinforced concrete skeleton construction will apply equally to skeleton steel structures of similar occupancy, because of life and occupancy hazards. (See General Requirements, Art. 3.)

IV. Floor Areas

As indicated in the 1926 Report, the Committee has given the subject of floor area limitation considerable study in an effort to provide reasonable extensions of area subject to a single fire for these buildings of the high grade of construction recommended by these specifications. Because of the probability of change of occupancy or use, it was found impracticable to concede greater areas on account of lower combustibility of contents. Accessibility with respect to street frontage has been limited to buildings of moderate height within reach of average fire department apparatus operating from the street. Particular attention is called to the relatively large areas permissible in high grade fire-resistive structures when subdivided by minor fire division partitions, in heavy timbered buildings having broad street frontage, and in all such standard buildings when equipped with approved automatic sprinkler protection.

V. Dryness of Slabs and Concrete Floor Filling

Opportunity should be given or means provided for the thorough drying-out of floor slabs and of the floor filling required by Arts. 39.4 and 71.8. Otherwise, wood sleepers and flooring should be of treated lumber.

VI. Water Damage

Provision is made in Art. 13, Drainage (General Requirements), for removal of the large quantities of water which may obtain in extinguishment of fire or by accident, without which floors of timber, concrete and composition construction are subject to more or less leakage, and often cause large damage to stock and/or machinery in stories below. Valuable occupancies susceptible to water damage should be protected by waterproofing the floors above, especially when the latter contain fire hazards necessitating large quantities of water for extinguishment. To be effective, the waterproofing should be carried up at least 4 inches at walls and around pipes or other openings.

It should be noted that while the specification requires relatively thick floors, waterproofing is advisable where reasonable tightness is not assured by the construction.

VII. Egress and Population

The Building Exits Code as applied to industrial establishments limits the allowable number of occupants in accordance with the exits provided. There are also certain minimum requirements, such as that providing two independent means of egress from every area, which apply irrespective of the population to be accommodated. The unit of measure of the width of stairways, etc., is 22 inches, which is the width required for a single file of persons. The Code gives tables in terms of population allowed per floor per 22-inch unit of exit width. The number of persons per unit is varied in accordance with the hazards, construction of the building, etc. Fundamentally it entitles slow-burning and fire-resistive construction to increased population over ordinary structures, permits material increase in occupancy for complete enclosure of all vertical shafts and inter-story communications, increase for full sprinklered protection, and awards special credit for ramps, horizontal exits, low hazard occupancies, and low buildings.

VIII. "Mill Construction"

The term "mill construction," by which buildings of heavy timber construction have quite generally been known, refers to their usual occupancy and is too inclusive for a definition of a structural type. Industrial buildings of steel frame construction, for example, also are known as mill buildings in some districts. The expression "slow-burning, heavy timber construction," used in Article 40, is preferred as being more specific and more descriptive.

IX. Column Cap Protection

Attention is called to the fact that by far the weakest point in heavy timber construction, with respect to resistance to fire, is at unprotected metal caps and pintles providing the structural connection between timber columns and girders. Unless column caps are of reinforced concrete or other fire-resistive construction, or are protected by fireproofing as specified in Art. 51.2, serious damage by floor settlement or actual collapse may occur in severe fires.

Pintle, cap and base-plate construction depends, for stability of the floor construction, upon the bracing afforded by bearing walls; bracket caps of reinforced concrete, iron and steel mutually anchor columns and girders rigidly to each other.

X. Roof Anchorage

Attention is called to the desirability of incorporating into the construction of a building those factors which will develop their resistance to windstorms. While damage from such storms is material even in localities not usually considered particularly subject to such phenomena, it is more preventable than usually appreciated. Lightweight or tall steel skeleton buildings require good bracing. Large areas of tile or concrete block walls need stiffening. Wooden roofs may be lifted if roof beams, wall plates, or joists are not securely fastened to other members, or anchored to masonry walls. Interior columns need secure fastening to remain in position and assist in anchoring the roof. Light clay tiles, weighing less than fifteen pounds per square foot, are readily blown off and even the heavier tile may require fastening in some positions. Corrugated iron and corrugated asbestos may be stripped from exposed locations, such as monitors, unless securely strapped.

XI. Lumber Standards

The American Lumber Standards represent agreement between producers, distributors and consumers of softwood lumber, in collaboration with the U. S. Departments of Commerce and Agriculture, as to recommended basic provisions for standard sizes and commercial grades. They were arrived at through careful study of construction needs and of practical lumber manufacturing possibilities and limitations. They should be made the basis, by manufacturers and consumers, of all commercial grades, specifications, and transactions involving softwood lumber.

XII. References

The following publications of the U. S. Department of Commerce referred to in this report may be obtained from the Government Printing Office, Washington, D. C. (Stamps not accepted.)

1. Minimum Live Loads for Use in Design of Buildings, Report of the Building Code Committee, 38 pages, 10 cents.
2. Recommended Minimum Requirements for Masonry Wall Construction, Report of the Building Code Committee, 57 pages, 15 cents.
3. Recommended Building Code Requirements for Working Stresses in Building Materials, Report of the Building Code Committee, 53 pages, 10 cents.
4. Revised Simplified Practice Recommendation, No. 16 Lumber (American Lumber Standards), 87 pages, 15 cents.

Recommendations of the National Fire Protection Association are obtainable at 60 Batterymarch Street, Boston, Mass. A nominal charge is made for certain publications.

Regulations and recommendations of the National Board of Fire Underwriters are obtainable at 85 John Street, New York.



References on Heavy Timber Construction

CHOOSING THE INDUSTRIAL BUILDING;

DETAILS OF HEAVY TIMBER MILL CONSTRUCTION,
Published by the National Lumber Manufacturers Association,
702 Transportation Building, Washington, D. C.

WOOD CONSTRUCTION, by the National Committee on
Wood Utilization, Department of Commerce, Washington, D. C.
Published by McGraw-Hill Book Co., New York City.

FACTORY MUTUAL INSURANCE,
Published by Arkwright Mutual Fire Insurance Company, Boston, Mass.

STANDARD SPECIFICATIONS FOR GRADES OF
DENSE SOUTHERN YELLOW PINE;

SOUTHERN PINE MANUAL OF STANDARD WOOD
CONSTRUCTION,—(10th Edition),
Published by the Southern Pine Association, New Orleans, La.

STANDARD GRADING AND DRESSING RULES FOR
DOUGLAS FIR;

PROPERTIES OF WEST COAST WOODS,
Published by West Coast Lumbermen's Association, 364
White-Henry-Stuart Bldg., Seattle, Washington.

HANDBOOK OF BUILDING CONSTRUCTION, VOL. I,
McGraw-Hill Book Co., Hool & Johnson.

TIMBER FRAMING, (being revised),
H. D. Dewell.

DRY ROT IN FACTORY TIMBERS, by *F. J. Hoxie*,
Published by Associated Factory Mutual Fire Insurance Co's., 184 High Street, Boston, Mass.

HANDBOOK OF FIRE PROTECTION, by *E. Crosby*, *H. A. Fiske*, and *H. W. Forster*,
Published by D. Van Nostrand Company, 25 Park Place,
New York.

WHERE ADDITIONAL SPECIFIC LUMBER INFORMATION MAY BE OBTAINED

AS the publications of the National Lumber Manufacturers Association deal with lumber in general, it is suggested that those desiring additional information regarding the respective species of woods listed below should make requests for definitions, grading rules, and publications concerning the special advantages and characteristics of each species to the following member associations affiliated with the National Lumber Manufacturers Association:

CALIFORNIA REDWOOD ASSOCIATION,
San Francisco, Calif.

Redwood

CALIFORNIA WHITE AND SUGAR PINE
MANUFACTURERS ASSOCIATION,

San Francisco, Calif.

*Sugar Pine, California White Pine, White Fir
Douglas Fir, Incense Cedar*

HARDWOOD MANUFACTURERS INSTITUTE,
Memphis, Tenn.

*Ash, Basswood, Beech, Birch, Cherry, Cypress, Chestnut,
Cottonwood, Elm, Gum, Hickory, Maple, Magnolia,
Oak, Poplar, Sycamore, Tupelo, Tennessee
Aromatic Red Cedar, Willow, Walnut*

NORTH CAROLINA PINE ASSOCIATION,
Norfolk, Va., and Macon, Ga.

North Carolina Pine

NORTHERN PINE MANUFACTURERS
ASSOCIATION,

Minneapolis, Minn.

Northern Pine

NORTHERN HEMLOCK AND HARDWOOD
MANUFACTURERS ASSOCIATION,

Oshkosh, Wis.

*Hemlock, Birch, Maple, Basswood, Elm, Ash, Beech
Tamarack, White Pine*

SOUTHERN CYPRESS MANUFACTURERS
ASSOCIATION,

Jacksonville, Fla.

Cypress, Tupelo

SOUTHERN PINE ASSOCIATION,
New Orleans, La.

Longleaf and Shortleaf Southern Pine

WEST COAST LUMBERMEN'S ASSOCIATION,
Seattle Wash., and Portland, Ore.

*Douglas Fir, West Coast Hemlock, Sitka Spruce,
Western Red Cedar, Port Orford Cedar*

WESTERN PINE MANUFACTURERS
ASSOCIATION,

Portland, Ore.

*Pondosa Pine, Idaho White Pine, Larch and Fir,
White Fir, Cedar and Spruce*



NATIONAL LUMBER MANUFACTURERS ASSOCIATION

General Offices

Transportation Building
Washington, D. C.

FIELD OFFICES

New York

Boston

Pittsburgh

Chicago

Indianapolis

Minneapolis

Kansas City

San Francisco

Memphis

New Orleans

Digitized by:



ASSOCIATION
FOR
PRESERVATION
TECHNOLOGY,
INTERNATIONAL
www.apti.org

BUILDING
TECHNOLOGY
HERITAGE
LIBRARY

<https://archive.org/details/buildingtechnologyheritagelibrary>

From the collection of:

Jim Draeger

Boston
Pittsburgh

Indianapolis
Minneapolis
Kansas City

Memphis
New Orleans